Non-Invasive, Head-Mounted Measures of Vestibular Function

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Description:
OBJECTIVE: Develop and test a single head-mounted device capable of measuring vestibular function to include assessment of vestibular-ocular, vestibular-auricular, vestibular-perceptual and vestibular spinal reflexes. DESCRIPTION: Dizziness and vertigo are common in nearly all reported studies of mTBI and contribute disproportionately to disability (Terrio et al., 2009). The 2009 in-theater IRAQ study by Balaban and Hoffer found vestibular pathology in over 90% of the observed cases of acute mTBI and over 80% of the chronic mTBI cases. Incidence rates vary depending on the injury cause, site, criteria and whether the clinician's primary expertise is neurological or otolaryngolocal. There is a need to develop simple, easy-to-use, portable screening devices to assess military personnel in theater to determine whether the patient needs to be evacuated for higher levels of care. In the United States, mTBI accounts for approximately 90% of the new cases of medically diagnosed head injuries each year and is associated with headache, dizziness, vertigo, disequilibrium, or disorientation, often in the absence of abnormal brain imaging results. (Gottshall et al., 2003). Recent advances in several technology areas including MEMS accelerometers and miniature high resolution cameras make feasible the development of a head-mounted assessment device that will permit objective measures of vestibular function. Traditional stimuli for vestibular reflex responses required acceleration of the head or body. Increased understanding of vestibular reflexes have led to new tests of vestibular function such as the cervical vestibular evoked myogenic potential (cVEMP) and the ocular vestibular evoked myogenic potential (oVEMP). The stimuli for these reflexes are loud clicks (CVEMP) or a tap on the forehead (oVEMP) which preferentially test the saccular or utricle function of the vestibular otolith organs. The combination of technology and understanding of vestibular function will permit a single well-designed, head-mounted display to

perform the assessment of several clinically important tests including: Vestibular Ocular Reflex (VOR); head thrust test of otolith function; electronystagmography; Dynamic Visual Acuity Test (DVAT); dynamic body balance and Subjective Visual Vertical (SVV). This project seeks the design and development of a device that will objectively assess as many aspects of static and dynamic vestibular function as is currently capable with available miniaturized technologies. This device will benefit military medics assessing vestibular dysfunction following concussive events as well as civilian clinicians diagnosing patients with balance disorders. PHASE I: Integrate a combination of vestibular tests to assist clinicians in the assessment of vestibular function. At a minimum the tests will include SVV, VOR, DVAT, head thrust, ocular counteroll and balance measures. Identify the best technologies to provide vestibular stimuli for the selected combination of tests as well as the optimal sensors to measure the reflex and perceptual responses. Develop and demonstrate a prototype capable of both providing stimuli as well as measuring responses. PHASE II: Refine the prototype developed in Phase I to demonstrate and clinically validate the capabilities in health care settings. Using feedback from operators testing in the clinical environment, provide technician-friendly interfaces for data collection and analysis. PHASE III DUAL USE APPLICATIONS: In conjunction with health care professionals transition the new device into clinical use both in the military and civilian sectors